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NMD Deployment Readiness Program Overview

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Abstract

This paper summarizes America's National Missile Defense Deployment Readiness Program and describes the defenses we are developing to defend the United States against ICBMs from the Third World. Some countries, including North Korea, are developing ICBMs indigenously but relatively slowly, while others could obtain ICBMs in the near term through proliferation. Effective defenses against such threats would include space-based and ground-based sensors for early warning, ground-based sensors at sites within the United States and, if needed, at forward bases, for identifying and tracking threat objects, ground based interceptors at one or more sites, and a battle management, command, control, and communications system for controlling the architecture and relaying its messages. Such a system, even with only one interceptor site, could defend all 50 States with high effectiveness against a few missiles from a Third World country. The uncertainties associated with when such a threat might appear, and from where, and with what characteristics, have dictated that we adopt a highly flexible and evolutionary "deployment readiness" acquisition program. With this program, we will reach an initial deployment readiness state in 1999. We will remain ready thereafter to deploy defenses at any time, within three years of a deployment decision.

Introduction

In this paper, we show how the DoD's National Missile Defense program has been crafted to prepare defenses that will meet United States needs when they develop. We begin with a historical perspective, to show how national threat perceptions and National Missile Defense requirements have varied over time, and why we have designed so much flexibility into the program. We describe potential ICBM threats and the potential times and places they might appear. We discuss the defense elements and systems needed to counter them. We conclude by showing how our program will prepare National Missile Defense systems that can deal effectively with the near-term threats, if they appear. If the United States doesn't opt for deployment in 2000, we will then enter a year-to-year improvement and testing cycle. In this way, we will be ready to deploy the most advanced and capable system of defenses available at the time when a deployment decision is needed.

History

In the United States we have had a 30-year evolution of ballistic missile defense programs. The evolution began with early studies in the 1950s and 1960s, to the construction and dismantling of Safeguard in the early 1970s, to President Reagan's seminal "Strategic Defense Initiative" speech in March, 1983, and on to the present. Throughout this time period one dominant theme of the United States's ballistic missile defense program has been change. The National Missile Defense mission has cycled more than once, from protecting people to defending weapons amd military forces and back. The threat source has also changed: from the Soviet Union to China and back, and now to the Third World. The only apparent constant is change itself.

Another dominant theme is technology evolution. Each successive step to more advanced ballistic missile defense systems, designed to defend against increasingly sophisticated threats, was made possible by innovations in technology. Many of these steps did not lead to an actual deployment, but each advance led to further development and increasing technical capability. In many ways, this historical evolutionary pattern is a model for the DoD's current National Missile Defense program.

Threat

Missile threats to the United States have existed for decades in the states of the former Soviet Union and, for less time, in the People's Republic of

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China (PRC). These threats are now evolving toward the Third World, in two ways. Indigenous missile development programs are underway at an intense pace. More worrisome, the risk of missile proliferation is increasing as missile-producing states are making their wares available on the world market. This section describes the current and potential threat climate, from Russia, the PRC, and the Third World.

When the intelligence community assesses ICBM threats to the United States, analysts look at both capability of each adversarial threat and the intention or probability of its use.

- "Capability" encompasses both the number of threat missiles in the adversary's inventory and the technical complexity of the threat. Typical threat-related questions are: How many ICBMs does an adversary have, and how many could he commit to an attack? Are they equipped with penetration aids? Are their warheads easy or difficult to detect?
- "Probability of Use" estimates of the likelihood that an adversary who has or will acquire ICBMs will use them to attack or blackmail us.

As shown in Figure 1, our concern would be greatest if we were to judge that the threat is both highly capable and likely to be used. Our concern would also peak if, as shown, a low-capability threat has a high probability of use.

NMD National Debate

The Cold War and the Gulf War are history. In the aftermath of these two major world events, a debate is taking place in this country about ballistic missile defense. The Gulf War showed us how valuable ballistic missile defense systems were in the Theater, and modernizing these short-range systems has become a national priority. However, the problems of what to do about defending the United States against long-range ballistic missiles, and when to do it, are proving to be more difficult to resolve.

The ongoing debate on National Missile Defense is grappling with these issues. Policy makers agree that we should develop defenses that will defend all 50 states effectively against modest Third-World threats; that we don't now know what specific Third-World threat we will have to face first; and that we may have to deploy initial defenses within six years (i.e., by 2003). They concur that we are constrained to some degree by the ABM Treaty in its present form. They share an interest in ensuring that any actions we take in ballistic missile defenses do not endanger or degrade our growing rapport with our former Cold War adversaries or the favorable arms control climate we now enjoy.

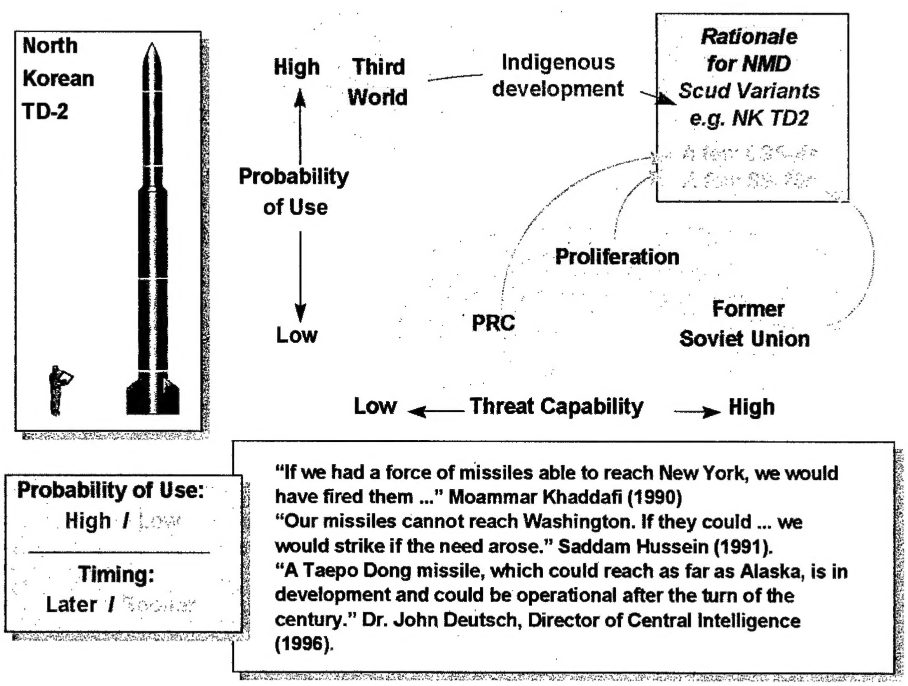

Figure 1. The third-world threat is of greatest concern, whether by indigenous development or, of more immediate concern, by proliferation.

The NMD Program Today

In response to the evolving geopolitical environment, the National Missile Defense program has been elevated from a Technology Readiness Program to a Deployment Readiness Program. A Joint Program Office is being established under the Ballistic Missile Defense Organization and given a charter to develop a National Missile Defense system for possible future deployment. The Department of Defense has also designated National Missile Defense as a Major Defense Acquisition Program (MDAP) to ensure that it receives an appropriate level of management attention and oversight.

The mission of the NMD system under development is to defend against an ICBM attack consisting of several missiles launched at the United States from a rogue nation, or a small accidental launch from China or from countries of the former Soviet Union. The system development is to be completed within three years and an integrated system test conducted by the end of 1999 to demonstrate the system's capabilities. The decision to deploy this system will be deferred until after a successful demonstration and the validation of a rogue nation threat. If a decision to deploy were made in 2000, the system could achieve operational capability in another three years, i.e., by the end of 2003. This strategy is commonly referred to as the "3+3" program. If a decision to deploy is not made in 2000, the program will work to improve the NMD deployment readiness posture by advancing the technology of each element and adding new elements, all the while maintaining the capability to deploy the system within three years of a decision.

NMD Architecture

A National Missile Defense architecture needs systems called "elements" to perform a number of key functions during a ballistic missile defense engagement.

The functions performed by the elements in a typical ballistic missile defense engagement are as follows. First, an *Early Warning Sensor* element detects the launch of one or more ballistic missiles and forms initial estimates of the missiles' tracks and targets. These estimates are then passed to the *Battle Management, Command, Control, and Communications System (BM/C3)* element. This system notifies the Command Center of the launch and provides data supporting the time-critical decision on whether the launch is hostile. The *BM/C3* element directs other *Sensor* elements to continue the tracking and threat identification function throughout the missile's trajectory. These elements provide data of two primary types: accurate tracking data to provide weapon engagement information; and detailed threat signature data to distinguish among warheads and other objects in the threat. The *BM/C3* element processes these data and continually relays current information to the human-in-control. Under human control, the *BM/C3* element provides specific threat and trajectory information to one or more ballistic missile defense *Weapon* elements and tasks the appropriate element to engage and destroy the threat warheads. The *Sensor* elements continue to provide improved observational data in support of ongoing engagements. Following each engagement, the *Sensor* elements observe the results of the engagement, providing "kill assessment" data with which to assess its success or failure.

The initial deployment BMDO is developing is being designed to defend all 50 states from a single, central United States site. It is being structured to defend effectively against small numbers of threatening warheads from rogue nations. The system elements, as they might be deployed for a notional single-site architecture defending the United States, are depicted in Figure 2.

The Ground Based Interceptors and a Ground Based Radar will be located at Grand Forks, North Dakota. Space sensors are not likely to be available if this architecture is deployed by 2003, so the architecture includes the option to use forward-based radars, whose location would depend on the specific Third-World threat against which the system is deployed.

The Early Warning satellites would detect the launch of one or more threat missiles and track their bright infrared plumes until booster burnout. They would pass an estimate of the threat trajectories via the Battle Management, Command, Control and Communications system to the command center, so that the decision maker can authorize the defense to engage the threat. The Early Warning Radars and any other forward based radars, if present, would gather tracking and threat assessment data to support commit of the interceptor and to provide guidance updates for the interceptor via the BM/C3 once it had been launched. Following weapon release authority, and upon command, one or more interceptors would be launched to engage the threat. Depending on the trajectory of the threat and the particulars of the defense deployment, the BM/C3 system would process the Ground Based Radar and

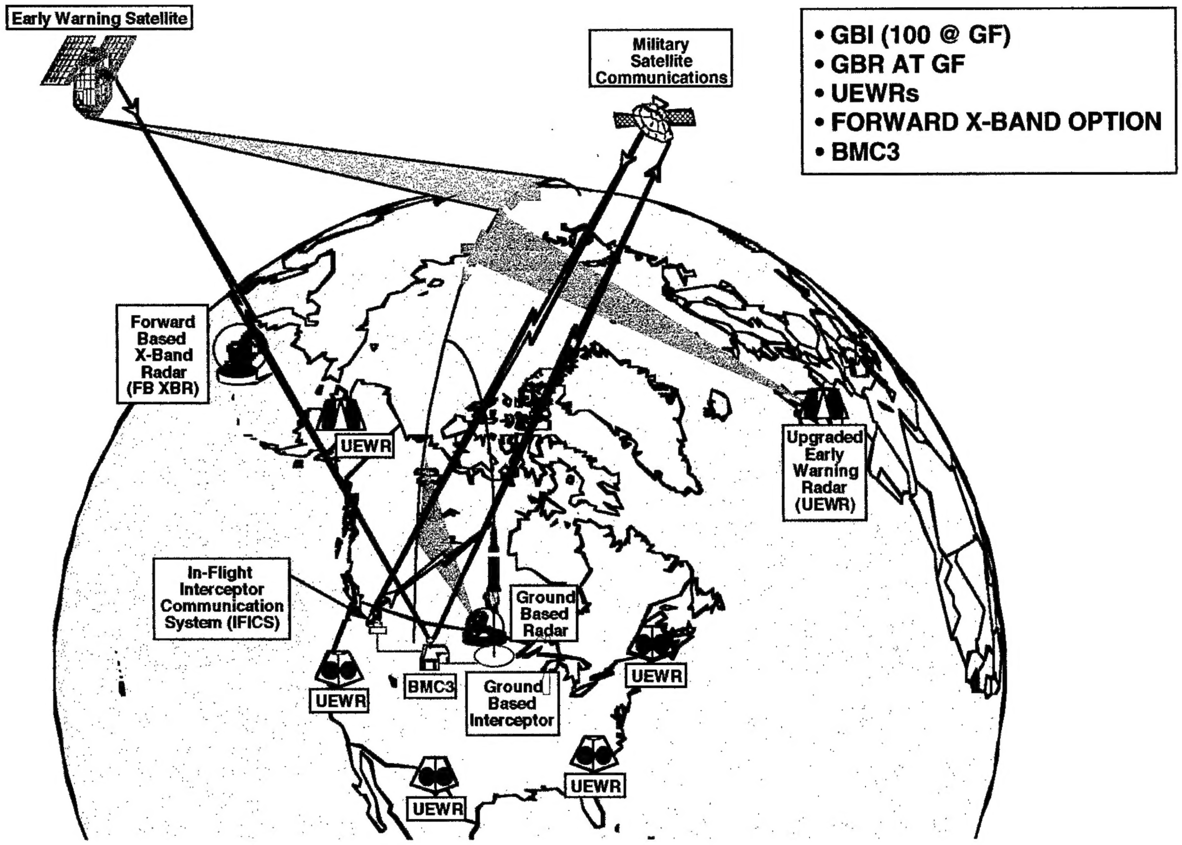

Figure 2. Notional initial single-site architecture for defense of the 50 United States.

the other radar systems data and provide further threat data to the interceptor during flight to support discrimination of warheads from penetration aids and for providing better interceptor guidance against the targets. As the interceptor approached the target, it would acquire the target objects using one or more on-board sensors, select a target from external and internal data, and be guided to a direct high-speed collision by its own computers and propulsion systems. The radars would continue to take data throughout the defense engagement in order to perform kill assessment. For some deployments and threats, there may be sufficient battle space to allow time for multiple waves of interceptors.

The NMD Systems Engineer, along with the Element engineering effort, play a crucial role in providing the necessary integration and orderly development of an NMD System which meets the user's requirements. The NMD Systems Engineer must ensure the optimum system is developed which meets all requirements and provides the proper balance of system performance, life cycle cost, development schedule, and risk. Much of the technology that makes up the individual elements of the NMD program is mature. The largest challenge is the integration of all the elements as a system. This challenge is being worked aggressively and it is at the centerpiece of the 3+3 strategy. The Systems Engineering and Integration contractor is on track for a Systems Requirements Review (SRR) in 1996. Results from this review could result in modifications to the NMD Architecture and a rebalancing of the element requirements to meet the system performance thresholds. Such modifications, if required, could cause a cost increase and a possible schedule delay.

The development program that will be executed over the next three years will be compliant with the ABM Treaty. The system components that are ultimately fielded, should a deployment decision be made after three years, might comply with the current treaty, or might require technical modification to the Treaty, depending on the specific threat situation at that time.

NMD Performance

This system would provide excellent protection of the US for small numbers of simple threats (e.g., a few warheads from a rogue nation) as

depicted in Figure 3. It would also have some capability against a small accidental launch from China.

The system is not designed to protect against an unauthorized launch which might contain a large number of warheads. If the number of threat missiles is more than "a few", or if the complexity of the threat increases, or both, then the performance of the basic system would be degraded. The degradation could be mitigated by adding interceptors and improved surveillance systems, including SMTS.

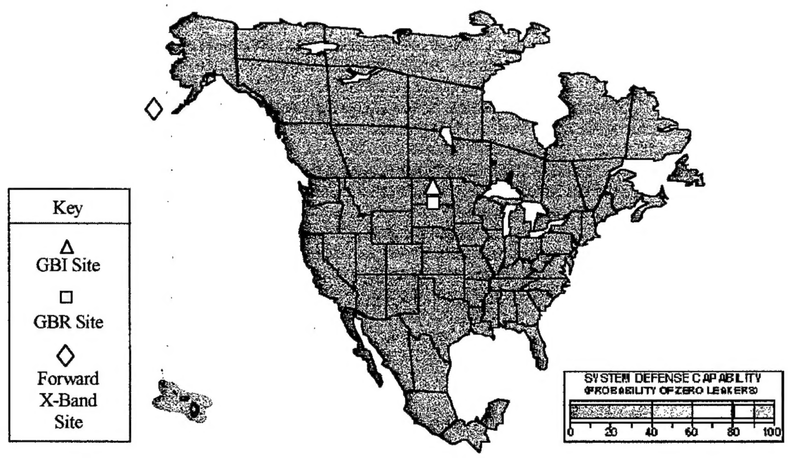

Figure 3. NMD Performance for Simple Threats

NMD Costs

The estimated costs to develop a notional single-site system would be about $2.5 billion, for a total program cost of about $10 billion to produce and deploy the initial system. Since the NMD program has just been designated a MDAP and is still in the process of developing the actual architecture for an NMD system, there is a significant uncertainty associated with this cost. For example, the actual booster selected for the NMD interceptor and the type and quantity of forward-based early warning radars, both which will have significant impact on the total system costs, have yet to be determined. A better estimate of the actual costs will be available by the end of the year.

NMD Elements

To perform the functions described above, BMDO is developing, testing, and integrating the major components of the system shown in Figure 4. The following paragraphs describe their individual functions and status.

Interceptor

The Ground Based Interceptor (GBI) and its associated components provide the "muscle" of the NMD system. The GBI's mission is to engage high speed ballistic missile warheads in the midcourse (exo-atmospheric) phase of their trajectories and destroy them by force of impact. The Ground Based Interceptor consists of:

- an intercept component called an exoatmospheric kill vehicle (EKV), to conduct the engagement,
- a booster, to propel the interceptor toward the approximate location to engage a warhead,
- the ground command and launch equipment needed to fire the interceptor.

EKV

The Exoatmospheric Kill Vehicle (EKV) is the intercept component of the Ground Based Interceptor. The EKV has its own sensors, propulsion, communications, guidance, and computing, with the following functions:

- Its sensors reacquire and track the objects in the threat and provide measurements that, when used with externally provided data, permit the selection of which object is to be engaged and support homing maneuvers including the selection of a lethal aim point.
- Its propulsion system changes the orientation of the interceptor, performs large-scale maneuvers to bring the vehicle to a position to engage the warhead, and conducts final fine-scale maneuvers to destroy the target warhead by impact.

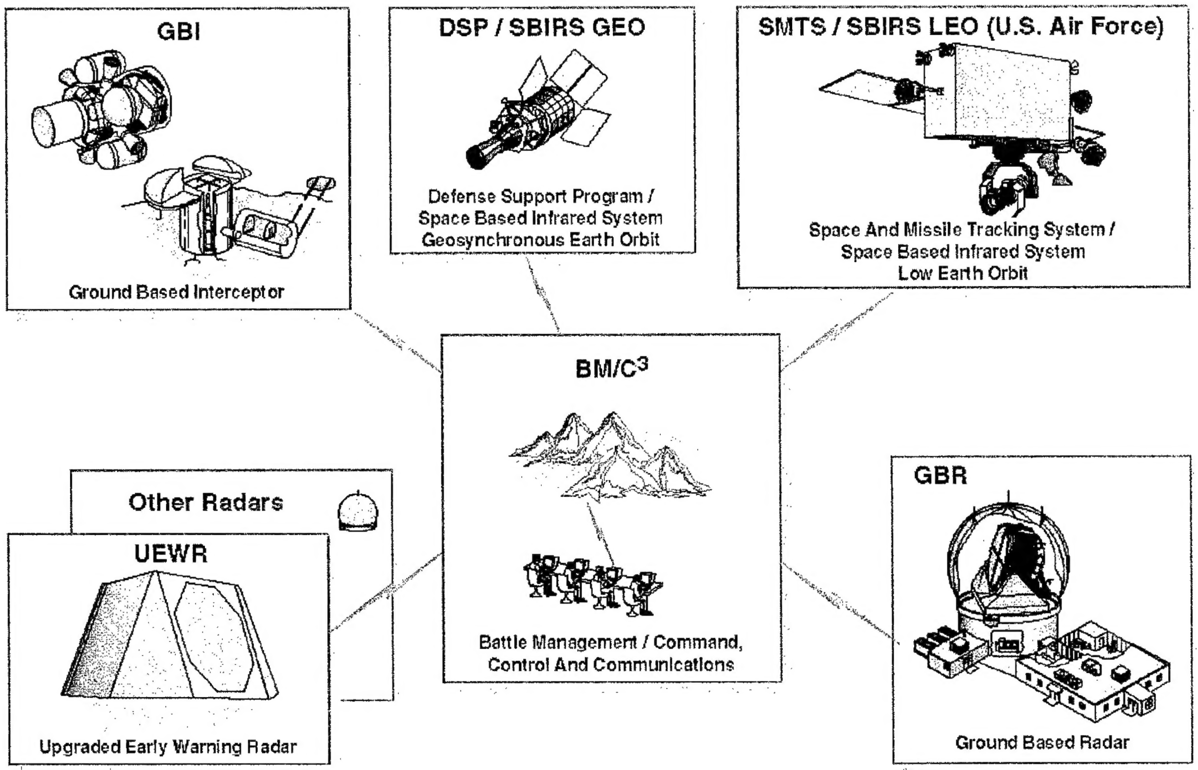

Figure 4. NMD System Elements

- Its two-way communications system receives guidance information updates and transmits health and status data; and

- Its computers support the engagement targeting decisions and maneuvers.

The major EKV component is a multiple-waveband infrared seeker which allows the EKV to acquire and track targets. The seeker consists of a focal plane array(s) and a cryogenic cooling assembly at the end of an optical telescope. The seeker is supported by processing hardware and software to support target acquisition, tracking, and discrimination.

Currently, the two EKV contractors utilizing two different sensor approaches are integrating sensor hardware in preparation for two sensor flight experiments. These experiments will demonstrate for the first time that our EKV sensors can operate in the flight environment. The data collected by the sensors will be transmitted to the ground and used after the flight to validate discrimination software and define any changes required.

Booster

The Ground Based Interceptor program will develop a new booster or modify an existing booster which can satisfy National Missile Defense coverage and time line requirements. To achieve 50-state coverage from a single central-United States interceptor site, interceptor velocities of more than 7 km/sec must be achieved. Until such a booster has been developed, Ground Based Interceptor tests are being supported by a Payload Launch Vehicle with significantly less boost velocity. When the full-capability booster has been tested to ensure proper operation and payload deployment, it will replace the Payload Launch Vehicle.

There are three candidate booster approaches being considered:

- *Combinations of existing missile stages.* A number of combinations of existing missile stages could provide the required performance. These candidates could be configured to provide booster burn times compatible with National Missile Defense engagement requirements, burnout

velocities compatible with 50-state coverage. All such configurations would feature demonstrated producibility in the quantities needed.

- *Development of a new booster.* This candidate could be based on either single stage or multiple stage technology. The advantage of new booster development is that the booster performance can be optimized for Ground Based Interceptor size (length and/or volume) and burn time requirements.

- *Reconfigure Minuteman boosters.* Major advantages include the use of existing hardware and an infrastructure which could be adapted to defensive use, as well as the ability to cover all 50 states from a single site.

Initiation of the decision and development of dedicated Ground Based Interceptor booster and launch equipment has been deferred until FY98.

Command and Launch Equipment

The Command and Launch Equipment consists of the hardware and software for BM/C3 interface, human-in-control oversight, interceptor storage (silos), launch and readiness functions. For a deployed system, Peculiar Support Equipment such as test equipment, specialized software support, and transportation equipment will also be acquired to fully support the integrated logistics support functions.

Site Radar

As a primary fire control sensor for the National Missile Defense, the Ground Based Radar (GBR) would perform surveillance, acquisition, track, discrimination, fire control support, and kill assessment. Before the launch of an interceptor, the radar would search for threat objects, either autonomously or in response to information from other sensors on where to look. After acquiring one or more threat objects, the radar would track them, estimate their trajectory parameters, and, based on threat-object signatures, attempt to classify them into categories such as "warheads" or "decoys." When the available information becomes sufficient, interceptors would be launched. During interceptor flight, the radar would continue to track the target to obtain improved target-trajectory and target-signature data. These data would be used to redirect the interceptor prior to its intercept attempt. Following the engagement, the radar would continue to collect data for assessing the intercept and the destruction of the target.

The National Missile Defense Ground Based Radar will be a phased array X-band radar. The radar will be built with a degree of hardening against nuclear effects, particularly against high-altitude electromagnetic pulse. The prototype version designed for use in the testing program will have reduced capabilities. The prototype radar can be modified if needed to give it objective-level performance.

The National Missile Defense Ground Based Radar Prototype is being procured through a "Family of Radars" acquisition approach that emphasizes commonality of hardware and software components to satisfy both theater-defense and national-defense radar requirements. Significant cost savings will result from this approach. The contract for the prototype ground based radar was executed in the first quarter of FY96.

Upgraded Early Warning Radars (UEWR)

Upgrades to America's Early Warning Radar network will provide existing forward-based attack warning system the capability to augment the operation of a National Missile Defense system. The specific advantage of utilizing upgraded early warning radars in the National Missile Defense architecture is that they can be modified on a very short schedule, and the cost of modifying these existing radars is significantly less than the cost of building and deploying new radars.

The Upgraded Early Warning Radars (UEWRs) will detect, track, and count the individual objects in a ballistic missile attack early in its trajectory. Their data will extend the detection capability of the ground based radars, by telling them accurately where to look; and the data will improve the performance of the ground based interceptors by permitting them to be launched early and to operate in a larger region of space.

A program is about to begin to prepare and demonstrate the needed upgrades to the existing early warning radars. Depending on the anticipated threat (east coast or west coast) at the time of a defense deployment decision, the appropriate BMEWS and/or PAVE PAWS radars will be upgraded for inclusion in the National Missile

Defense architecture. If needed, other existing forward-based radars (such as Cobra Dane or HAVE STARE) could also be used to support National Missile Defense.

Significant risks are involved in the UEWR program. The radars are old, and spare parts are difficult to obtain. Their long term availability is by no means assured. These radars are costly to operate and maintain. A viable operations and maintenance program will have to be agreed to if these systems are to remain part of the architecture. Their removal would increase risk and reduce system performance.

Forward Deployed Radars

Forward basing of a ground based radar places the radar where it can obtain accurate data from early parts of an ICBM's trajectory. The advanced technology associated with X-band radars provides high angular resolution, thereby permitting effective performance against closely spaced threat objects. Together these radar attributes provide for early and accurate target-tracking and signature data, permitting earlier launch of defense interceptors and a greater battle space within which they can operate. The overall defense performance is thereby maximized.

Battle Management, Command, Control and Communications (BM/C3)

Through the (BM/C3) element, the Commander in Chief of the North America Air Defense Command would control and operate the system, and the elements will function together as an integrated system.

The Battle Management, Command, Control and Communications element is the "brains" of the National Missile Defense system. It has five main functions:

- It conveys information to the operational command and control system, and provides decision aids to support essential human-in-control decisions;

- It fuses data from different sensors;

- It develops plans for engagement and battle execution;

- It relays command and control decisions and directives to the defense system, including weapon release, to implement a successful defense of the United States against ballistic missiles; and

- It is the vehicle for information transfer and processing among the elements of the defense system,

The Battle Management, Command, Control and Communications element supports the user with extensive decision support systems, displays, and situation awareness information. It correlates the best available intelligence information, current National Missile Defense system status, and data from all sensors and sensor systems. In this way, it supplies the means to plan, select, and adjust missions and courses of action; and it provides the vehicle to disseminate Weapons Release and other Command decisions to the National Missile Defense system elements.

An evolutionary development approach based on a "build-a-little, test-a-little" philosophy has been adopted for the Battle Management, Command, Control and Communications element. This approach is appropriate for systems with heavy user interfaces because such systems require significant user involvement and feedback during requirements definition and in the implementation phase.

In FY1995 BMDO awarded a Battle Management, Command, Control and Communications / System Engineering and Integration Contract for the development of BM/C3.

Space And Missile Tracking System (SMTS)

In addition to the elements being developed by BMDO, future NMD systems will significantly be enhanced by the sensing capability of the Space and Missile Tracking System (SMTS) which is being developed by the Air Force as part of the Space-based Infrared System (SBIRS). SMTS is allocated those mission requirements that are best met by a low-altitude system with long-wavelength infrared sensors, primarily the ballistic missile defense mission. The unique orbit and sensors on SMTS will also provide valuable technical intelligence and battle-space characterization data.

Each SMTS satellite will carry a suite of passive sensors that will provide surveillance, tracking, and discrimination data, including short-,

medium-, and long-wavelength infrared sensors, which detect objects by their heat emissions, and visible light sensors that use scattered sunlight. These sensors, which can be instructed to look in different directions independently of each other, will provide global (below-the-horizon and above-the-horizon) coverage of ballistic missiles in their boost, post-boost, and midcourse phases. SMTS can detect and track objects at very long distances by observing them against the cold background of space.

NMD Program Structure

The structure of the Deployment Readiness Program as an evolutionary acquisition program is depicted in Figure 5. The Deployment Readiness Program is gathering the ongoing element programs into an overarching program that combines integration and system testing while completing the remaining element engineering issues. Our testing plans focus strongly on system simulation and validation; in this era of simulation based design and testing, we can count on saving considerable funding through reliance on validated simulation practices.

The Deployment Readiness Program development phase will result in FY1999 in an "Integrated System Test (IST)", i.e., the full test of an integrated defense system. The system demonstrated in the test could, if warranted, be deployed to an initial operational capability within about three years of a decision to do so. This is the BMDO "3+3" program.

Following the IST, a deployment decision might not be warranted at that time due to the absence of a perceived threat. The United States could continue along the path of integrating and demonstrating advanced systems that incorporate new technologies. We would begin with the inclusion of space sensors, i.e., SMTS, and would continue with more advanced technologies and systems of increasing maturity and capability, until such time as a deployment decision is warranted. The "Advanced Options" could include multiple site architectures, or multiple layer architectures. Such architecture options could include maritime systems, as suggested by the Heritage Foundation "Team B" activity, or space based interceptors, or different classes of directed energy systems, such as lasers or particle beams. What options would be selected for deployment would depend on the threat to which we are responding, the ballistic missile defense technologies ready to be deployed, and the constraints associated with the ABM Treaty, all assessed at the time of the deployment decision.

Another significant challenge is meeting the aggressive schedule. To achieve this end, BMDO has put into place a flat organization, embodied in a new Joint Program Office and reporting to the Ballistic Missile Defense Acquisition Executive. Additionally, the Joint Program Office has adopted new streamlined acquisition practices, including the extensive use of Integrated Product Teams, which are addressing problem areas early and aggressively.

Summary

The NMD Deployment Readiness Program is designed to complete the necessary element development and system integration to demonstrate an initial missile defense capability for the United States in FY1999. This capability would provide the basis for a deployment decision that could allow deployment in 3 years if a threat was deemed imminent to the United States. The program is designed to continue to improve operational capabilities and to consider and integrate new advanced technologies into future systems.

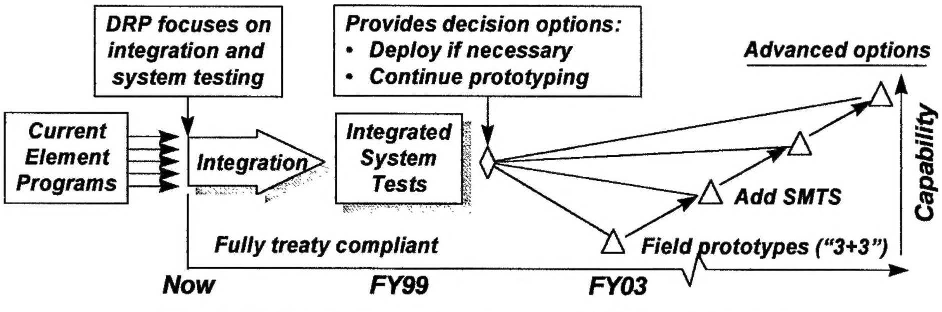

Fig. 5. Evolutionary acquisition – the BMDO 3+3 Program